MULTIMEDIA UNIVERSITY

STUDENT ID NO

TABLE NO: _____

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2015/2016

TCP2101 – ALGORITHM DESIGN AND ANALYSIS / TCS3211 – ALGORITHM ANALYSIS

(All Sections / Groups)

3 JUNE 2016
3.00 p.m. – 5.00 p.m.
(2 Hours)

Question	Mark
1	
2	
3	
4	
Total	

INSTRUCTIONS TO STUDENT

1. This Question paper consists of 11 pages with 4 Questions only.
2. Answer all **FOUR** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please write all your answers on **this Question paper.**

Question 1

a) An algorithm can be analyzed through 2 techniques: Experimental Studies, and Theoretical Analysis. Write down **the key steps** in each technique. [4 marks]

b) An algorithm named **Unknown** is provided below.

i) Fill in the column named Number of Primitive Operations, and find the time complexity of the algorithm in big-O notation. [5 marks]

Algorithm Unknown (A, n) Input: Array A of n ≥ 1 integers Output: Array A with new values	Number of Primitive Operations in Big-O notation
for i←0 to n-2 do	
$index$ ← i	
for j←n-1 downto i+1 do	
if $A[j]$ < $A[index]$	
$index$ ← j	
if $index$!= i	
swap ($A[i]$, $A[index]$)	
$T(n)$	

Continued...

ii) Use the Unknown algorithm above, fill the value of $A[i]$ into the last row of table below.

[3 marks]

i	0	1	2	3	4	5
A[i] before Unknown is executed	9	5	11	2	7	4
A[i] after Unknown is executed						

iii) The Unknown algorithm is actually a well-known algorithm. Write down the **name** of the algorithm.

[2 marks]

c) What is the **main purpose** of using hash table? What are the **best case time complexity** and **worst case time complexity** for hash table? When will the best case and worst case occur?

[5 marks]

Continued...

d) The following sequence of integers is provided.

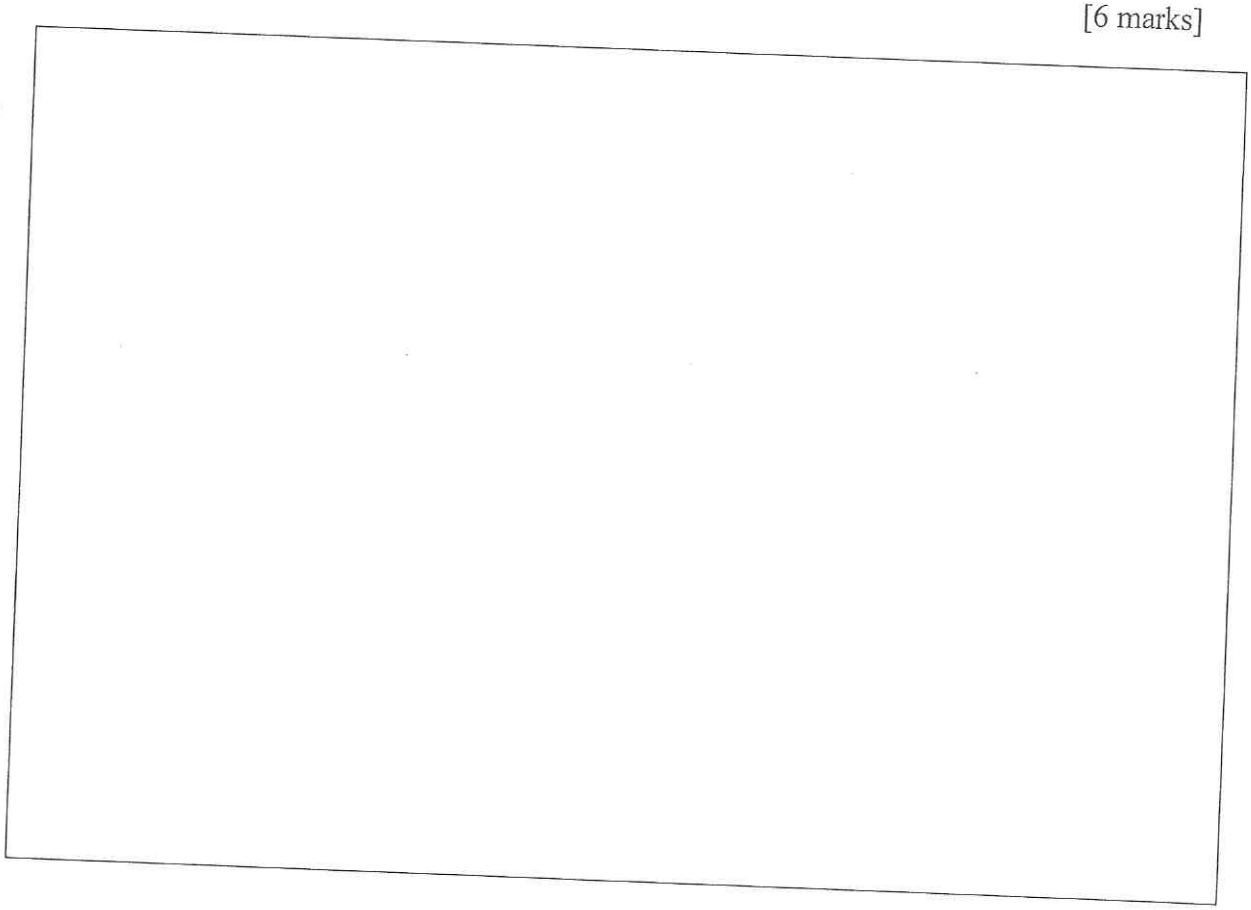
```
13 9 31 8 17 5
```

Find out the **hash value** for each element in the above sequence using the following hash function.

```
h(k) = k % 9
```

Then create a hash table for the sequence. Use **linear probing** to resolve collision.

[6 marks]



Continued...

Question 2

a) Based on the sequence of numbers provided below, create a **Binary Search Tree** (BST). Is the BST **balanced**? **Explain** your answer why it is balanced or unbalanced. [7 marks]

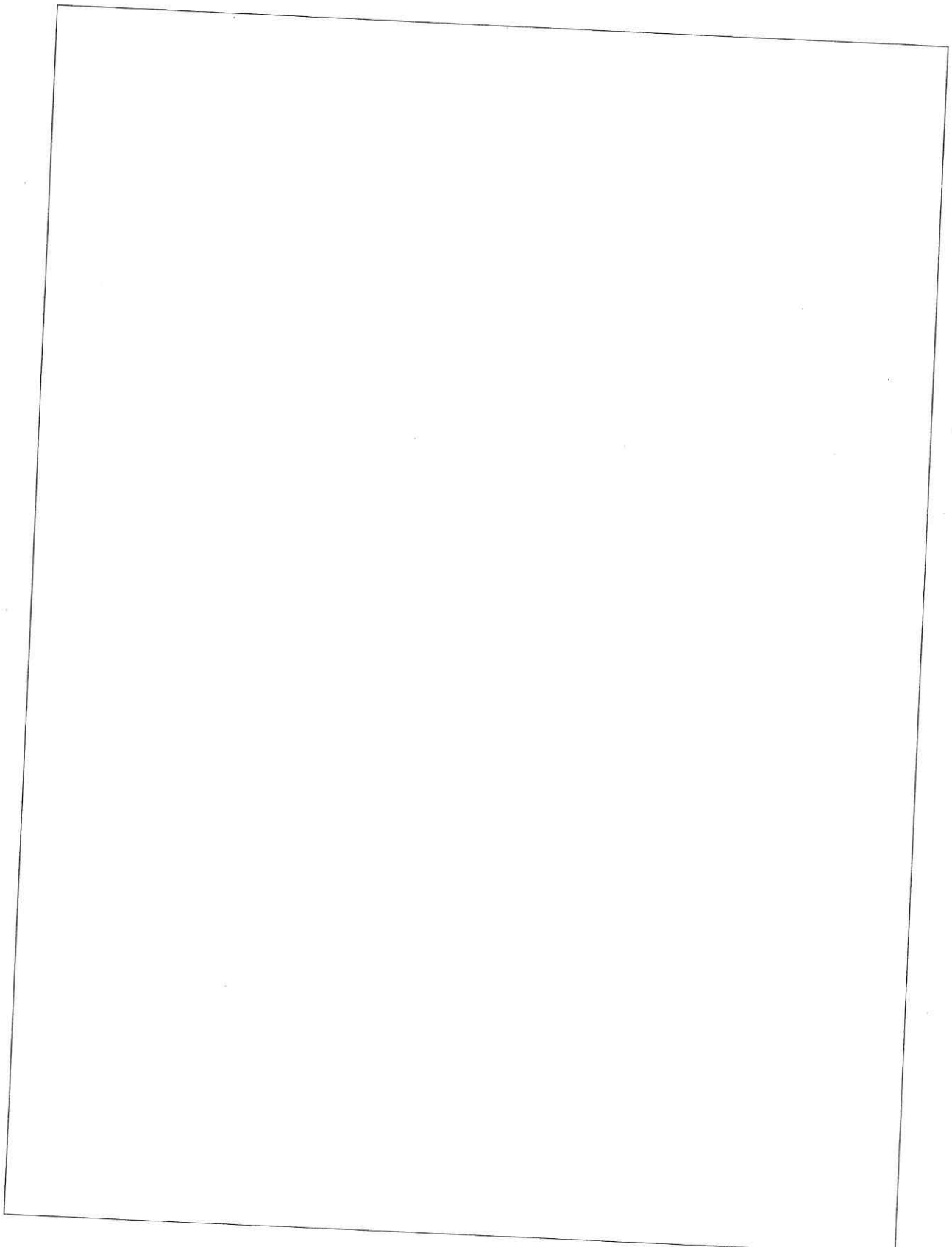
```
66 76 80 33 12 11 46 50
```

b) There are two techniques in creating a heap from a sequence of numbers. The **first technique** is to enqueue one number at a time. The **second technique** is to create an initial heap straightaway from the whole sequence. Use time complexity to **explain** which technique is faster. [3 marks]

Continued...

c) Based on the sequence of numbers provided below, create an **initial heap** (straightaway from the whole sequence). Use **max heap** (largest element at the root). Show the **intermediate results** (steps).

23 10 35 42 61 72 49 60 52 83 [6 marks]



Continued...

d) Quick-sort algorithm consists of two functions: a recursive quicksort function and a partition function. Complete the pseudocode for the **recursive quicksort function**.

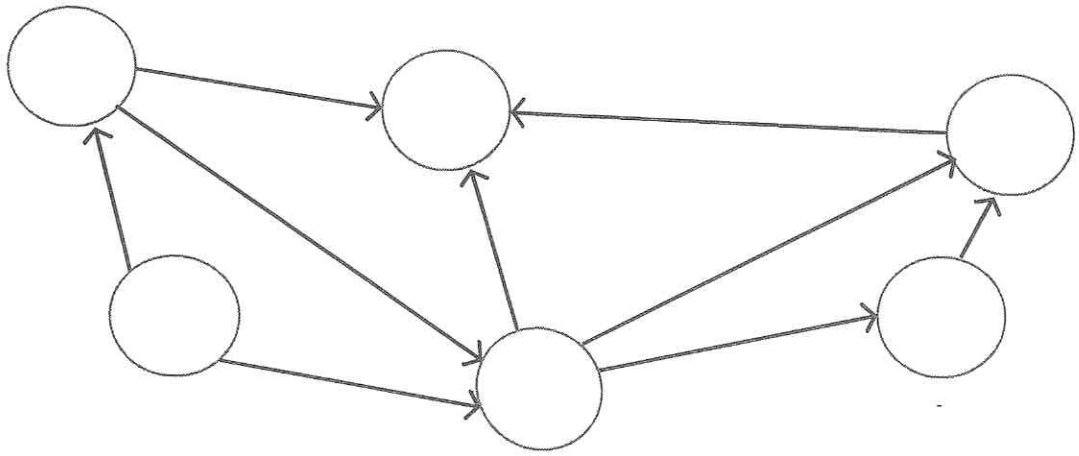
[3 marks]

```
function quicksort( arr, p, r )
Input: Array arr where p is the starting index and
       r is the ending index.
if p < r {
```

```
}
```

e) The following graph is provided. Find the **Topological Sorting** of the graph by labeling number 1-6 in the blank vertices.

[6 marks]



Continued...

Question 3

a) The **Master Theorem** is used to find the time complexity $T(n)$ for a recurrence equation. Given the three cases of Master Theorem at below, find the time complexity (in big-O) for the recurrence equations in part (i) and (ii). [8 marks]

1. if $f(n)$ is $O(n^{\log_b a-\varepsilon})$, then $T(n)$ is $\Theta(n^{\log_b a})$
2. if $f(n)$ is $\Theta(n^{\log_b a}\log^k n)$, then $T(n)$ is $\Theta(n^{\log_b a}\log^{k+1} n)$
3. if $f(n)$ is $\Omega(n^{\log_b a+\varepsilon})$, then $T(n)$ is $\Theta(f(n))$, provided $af(n/b) \le \delta f(n)$ for some $\delta < 1$.

i) $T(n) = T(n/3) + \log^2 n$

ii) $T(n) = 4T(n/2) + n\log^3 n$

Continued...

b) Name TWO sorting algorithms that are based on **divide-and-conquer** approach. Then state the **worst-case** time complexity for each of them. [4 marks]

c) Assume that you use **radix-sort** to perform sorting on the **hexadecimal numbers**, how many "bucket" will you use? **Explain** your answer. [3 marks]

Continued...

d) Use **dynamic programming** to find the optimal matrix chain-product for 4 matrices (P1xP2xP3xP4). The 4 matrices and their dimension are provided below:

P1: 12 x 8, P2: 8 x 5, P3: 5 x 15, and P4: 15 x 20.

Fill up the following table with the optimal solution calculated from the multiplication of matrix chain. Show your **calculation**. [10 marks]

	P_1	P_2	P_3	P_4
P_1	0			
P_2		0		
P_3			0	
P_4				0

Continued...

Question 4

a) Among the three text matching algorithms, i.e. Brute-Force, Boyer-Moore and Knuth-Morris-Pratt, which one is significant faster (in terms of speed) on English text? **Explain** your answer. State the **worst-case time complexity** for this text matching algorithm.

[4 marks]

b) Define the terms **NP-hard** and **NP-complete** for a problem. Give any TWO NP-complete problems.

[4 marks]

Continued...

c) Use **Merge-sort** to sort the following sequence of numbers. Show the **intermediate results**. Write down the **time complexity** of Merge-sort. **Explain briefly** why Merge-sort is a **not-in-place** algorithm? [9 marks]

52 10 61 42 72 49 60

d) Use **fractional knapsack** algorithm to find the maximum total benefit with weight (W) of at most **12**kg. List the **selected items** and the **maximum total benefit**. [8 marks]

Item	C1	C2	C3	C4	C5
Weight (kg)	7	3	8	5	4
Benefit	21	12	28	30	28

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